

WHAT IS CLAIMED IS:

- 1 1. A method for measuring optical tissues of an eye, the method
2 comprising:
3 transmitting an image through the optical tissues;
4 determining local gradients across the optical tissues from the transmitted
5 image; and
6 mapping an error-correcting change in the optical tissues by integrating across
7 the gradients.
- 1 2. The method of claim 1, wherein the image is transmitted from the
2 retina anteriorly through the optical tissues.
- 1 3. The method of claim 2, further comprising transmitting a source image
2 from a light source posteriorly through the optical tissues and onto the retina to define the
3 image.
- 1 4. The method of claim 3, wherein the image comprises a small spot or
2 point.
- 1 5. The method of claim 3, wherein the image is transmitted posteriorly
2 through a central region of the cornea, the central region having a size which is significantly
3 less than a pupil size of the eye.
- 1 6. The method of claim 5, wherein the central region has a width of
2 between about 1 and 4 mm.
- 1 7. The method of claim 2, wherein the mapping step comprises deriving a
2 proposed change in the optical tissue surface elevations so as to effect a desired change in
3 optical properties of the eye, and further comprising modifying the optical tissue surface
4 according to the proposed change by laser ablation.
- 1 8. The method of claim 1, wherein the image is transmitted by the optical
2 tissues as a plurality of beamlets, wherein the gradients comprise an array of gradients, each
3 gradient corresponding to an associated portion of an optical surface, each beamlet being
4 transmitted through the optical tissue according to the corresponding gradient.

1 9. The method of claim 8, wherein the integrating step comprises
2 integrating along a closed integration path across the gradient array.

1 10. The method of claim 9, further comprising determining an accuracy of
2 the gradient array by calculating a change in elevation along the closed integration path.

1 11. The method of claim 9, wherein the closed integration path extends
2 from a first center of a first portion of the optical surface to a second center of a second
3 portion of the optical surface, from the second center to a third center of a third portion of the
4 optical surface, and from the third center back to the first center, the first, second and third
5 portions of the optical surface corresponding to the first, second and third gradients of the
gradient array, respectively.

1 12. The method of claim 9, wherein the closed integration path extends
from an initial location corresponding to a position between a first gradient array element and
a second gradient array element, the path crossing a first portion of the optical surface
corresponding to the second gradient array element, a second portion of the optical surface
corresponding to a third gradient array element, and a third portion of the optical surface
corresponding to a fourth gradient array element before returning back to the initial location.

1 13. The method of claim 1, further comprising adjusting the image with an
2 adaptive optical element so as to compensate for errors of the optical system.

1 14. The method of claim 1, wherein an elevation map of an optical surface
2 of the optical system is generated directly in the mapping step without deriving coefficients
3 of a series expansion mathematically approximating the optical surface.

1 15. A method for measuring optical tissues of an eye, the method
2 comprising:
3 transmitting an image through the optical tissue;
4 determining local gradients across the optical tissue from the transmitted
5 image; and
6 mapping a wavefront error of the eye by integrating the gradients across the
7 tissue.

16 The method of claim 15, wherein the step of integrating further comprises:

integrating along a closed integration path across a gradient array.

17. The method of claim 16, further comprising determining an accuracy of the gradient array by calculating a change in elevation along the closed integration path.

18. A method of determining an accuracy of a gradient array in an optical tissue measurement comprising:

- transmitting an image through the optical tissue;
- determining local gradients across the optical tissue from the transmitted image; and
- integrating along a closed integration path across a portion of the array.

19. The method of claim 18, further comprising:
calculating a change in elevation along the closed integration path across the
portion of the array.

20. The method of claim 18 wherein, the closed integration path comprises:

a common starting point, a common ending point, a first integration path connecting the common starting point to the common ending point, and a second integration path connecting the common starting point to the common ending point, the first and second integration paths being different.

21. A system for diagnosing an eye of a patient, the eye having a retina and optical tissues, the system comprising:

an image source arranged to direct an image posteriorly through the optical tissues and onto the retina;

a wavefront sensor oriented to sense the image as transmitted anteriorly by the optical tissue, the wavefront sensor generating signals indicating gradients across the optical tissues; and

a processor having an integration module configured for integrating among the gradients to determine a map for correction of the optical tissues.

1 22. The system of claim 21, wherein the processor directly determines a
2 surface elevation map of an optical surface without generating coefficients of a series
3 expansion mathematically approximating the surface.

1 23. The system of claim 21, wherein the processor comprises a computer
2 executable code performing the method of claim 15 or 18.

1 24. A method of measuring a tomographic wavefront error map of an eye,
2 the method comprising:

3 deflecting a light measurement path of a wavefront sensor to a first angular
4 orientation relative to the eye;
5 measuring the eye at the first angular orientation;
6 deflecting the light measurement path to a second angular orientation;
7 measuring the eye at the second angular orientation; and
8 calculating the tomographic wavefront error map of the eye from the
9 sequential measurements, the map comprising a plurality of localized optical tissue surfaces
10 of the eye at different depths of the eye.

1 25. The method of claim 24 wherein a first optical tissue surface is
2 measured at the first angular orientation and a second optical tissue surface is measured at the
3 second angular orientation, and further comprising:

4 forming a light structure having a feature on a retina of the eye; and
5 repeating the steps of measuring and deflecting to obtain a plurality of
6 sequential optical tissue surface measurements..

1 26. The method of claim 25 further comprising displacing a position of the
2 light structure from a first position to a second position so that a feature of the light structure
3 in the second position is resolvable from the feature of the light structure in the first position.

1 27. A method of selecting an aberration of an eye for treatment

2 comprising:

3 calculating a tomographic wavefront error map of an eye comprising a
4 plurality of localized optical tissues surfaces of the eye;
5 corresponding the aberration with a tissue structure of the eye;

selecting the aberration for treatment in response to the structure corresponding to the aberration; and

combining a plurality of aberrations selected for treatment to obtain an optical treatment surface.

28. The method of claim 27 further comprising including the aberration corresponding to a corneal tissue structure of an eye and excluding the aberration corresponding to a lenticular tissue structure of an eye.

29. The method of claim 27, wherein the plurality of aberrations selected for treatment is a subset of a plurality of aberrations of the eye.

30. A method of selectively treating an aberration in an optical tissue surface of an eye comprising:

corresponding the aberration with a tissue structure of the eye;
selecting the aberration for treatment in response to the structure
corresponding to the aberration;

combining a plurality of aberrations selected for treatment to obtain an optical treatment surface; and

sculpting a cornea of the eye with a pattern of laser beam pulses to correct for the selected aberrations of the optical treatment surface.

31. The method of claim 30 further comprising including the aberration corresponding to a corneal tissue structure of an eye and excluding the aberration corresponding to a lenticular tissue structure of the eye.

32. A method of measuring a wavefront map of an eye comprising:

deflecting a light measurement path of a wavefront sensor to a first angular orientation relative to the eye;

measuring a first optical tissue surface of the eye at the first angular orientation of the measurement path relative to the eye;

deflecting the light measurement path to a second angular orientation;

measuring a second optical tissue surface at the second angular orientation;

and

calculating the wavefront error map of the eye from the sequential optical tissue surface measurements.

1 34. The method of claim 33 further comprising:
2 forming a light structure having a feature on the retina; and
3 displacing a position of the light structure from a first position to a second
4 position so that a feature of the light structure in the second position is resolvable from the
5 feature of the light structure in the first position.